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Liu et al.

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(45) **Date of Patent: Nov. 1, 2022**

(54) **DISPLAY PANEL INCLUDING AN ORGANIC ELECTROLUMINESCENT DEVICE WHERE AN ORGANIC SMALL MOLECULE LUMINESCENT MATERIAL IS DISPOSED IN A MAIN BODY MADE OF MESOPOROUS SILICA, METHOD FOR MANUFACTURING THE SAME, AND DISPLAY DEVICE**

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(73) Assignee: **HKC CORPORATION LIMITED**, Shenzhen (CN)

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H01L 29/08 (2006.01)
H01L 51/50 (2006.01)
H01L 51/56 (2006.01)

(52) **U.S. Cl.**
CPC ***H01L 51/5024*** (2013.01); ***H01L 51/5036*** (2013.01); ***H01L 51/5056*** (2013.01); ***H01L 51/5092*** (2013.01); ***H01L 51/56*** (2013.01)

(58) **Field of Classification Search**
CPC H01L 51/5024
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

9,859,497 B2 * 1/2018 Salcedo Reyes H01L 51/502
2011/0095271 A1 4/2011 Bradley
(Continued)

FOREIGN PATENT DOCUMENTS

CN 102460764 A 5/2012
CN 103824877 A 5/2014
(Continued)

OTHER PUBLICATIONS

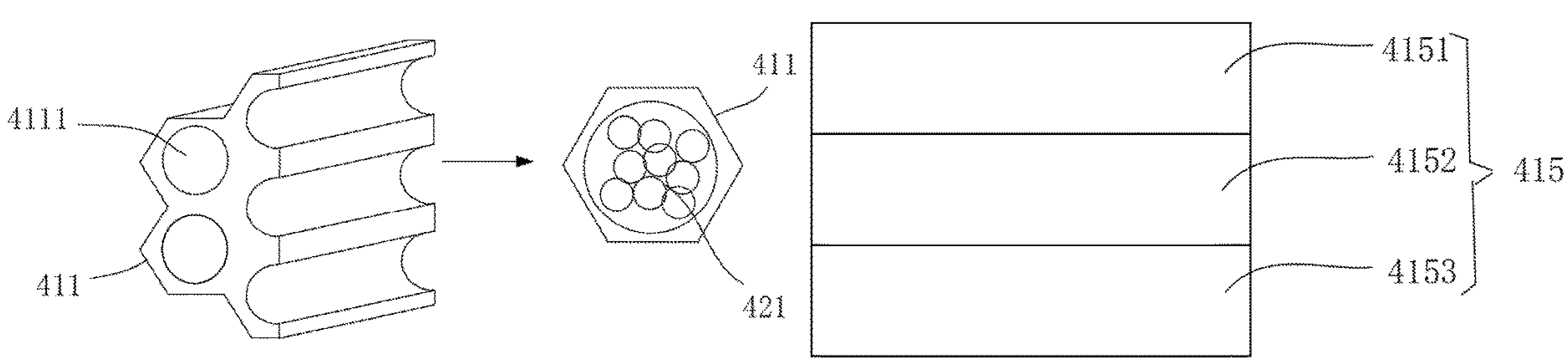
Peng Zhang, the ISA written comments, dated Sep. 2019, CN.
Peng Zhang, the international Search Report, dated Sep. 2019, CN.

Primary Examiner — Caleb E Henry

(57) **ABSTRACT**

This application discloses a display panel, a method for manufacturing a display panel, and a display device. The display panel includes an organic electroluminescent device. The organic electroluminescent device includes an emission layer. The emission layer includes a main body made of mesoporous silica and a dopant made of an organic small molecule luminescent material. The dopant is arranged in the main body.

17 Claims, 12 Drawing Sheets



(56) **References Cited**

U.S. PATENT DOCUMENTS

2016/0343948	A1*	11/2016	Salcedo Reyes	H01L 51/5024
2017/0117444	A1*	4/2017	Stoll	H01L 51/5281
2017/0362579	A1*	12/2017	Zheng	C12N 9/0006
2018/0019411	A1*	1/2018	Otsuki	H01L 51/0072
2018/0050220	A1*	2/2018	Sepahvandi	A61L 27/26

FOREIGN PATENT DOCUMENTS

CN	105720176	A	6/2016
CN	106449720	A	2/2017
CN	107689388	A	2/2018
CN	108565349	A	9/2019

* cited by examiner

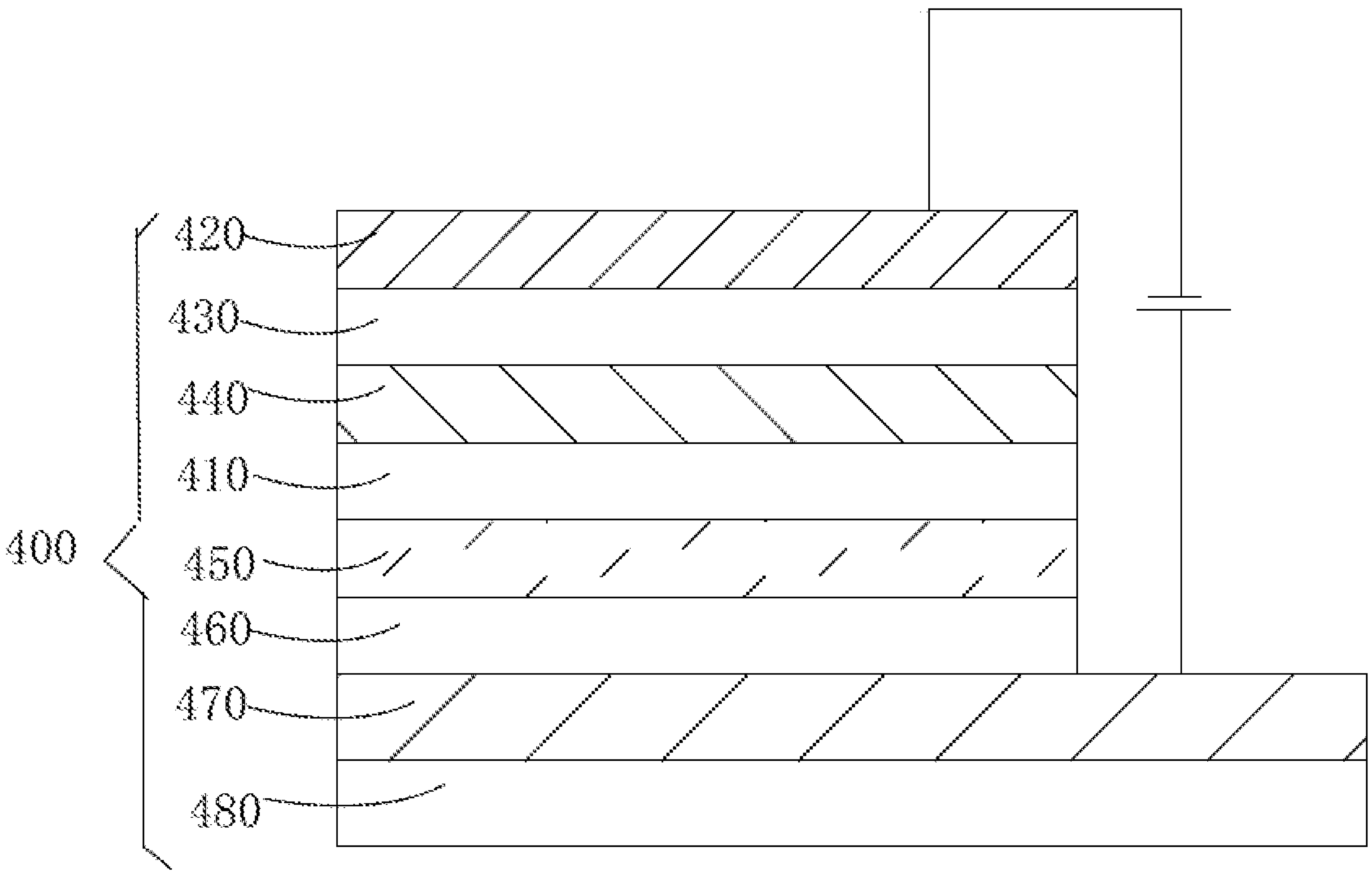


FIG. 1

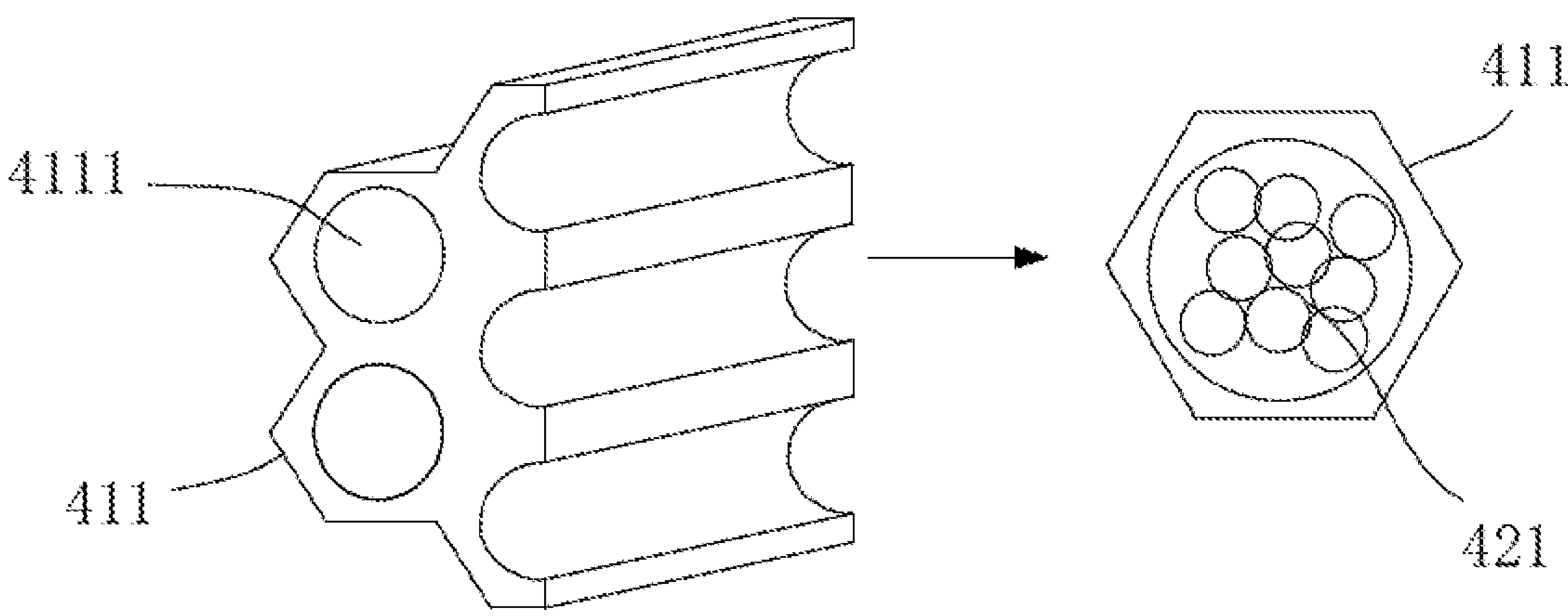


FIG. 2

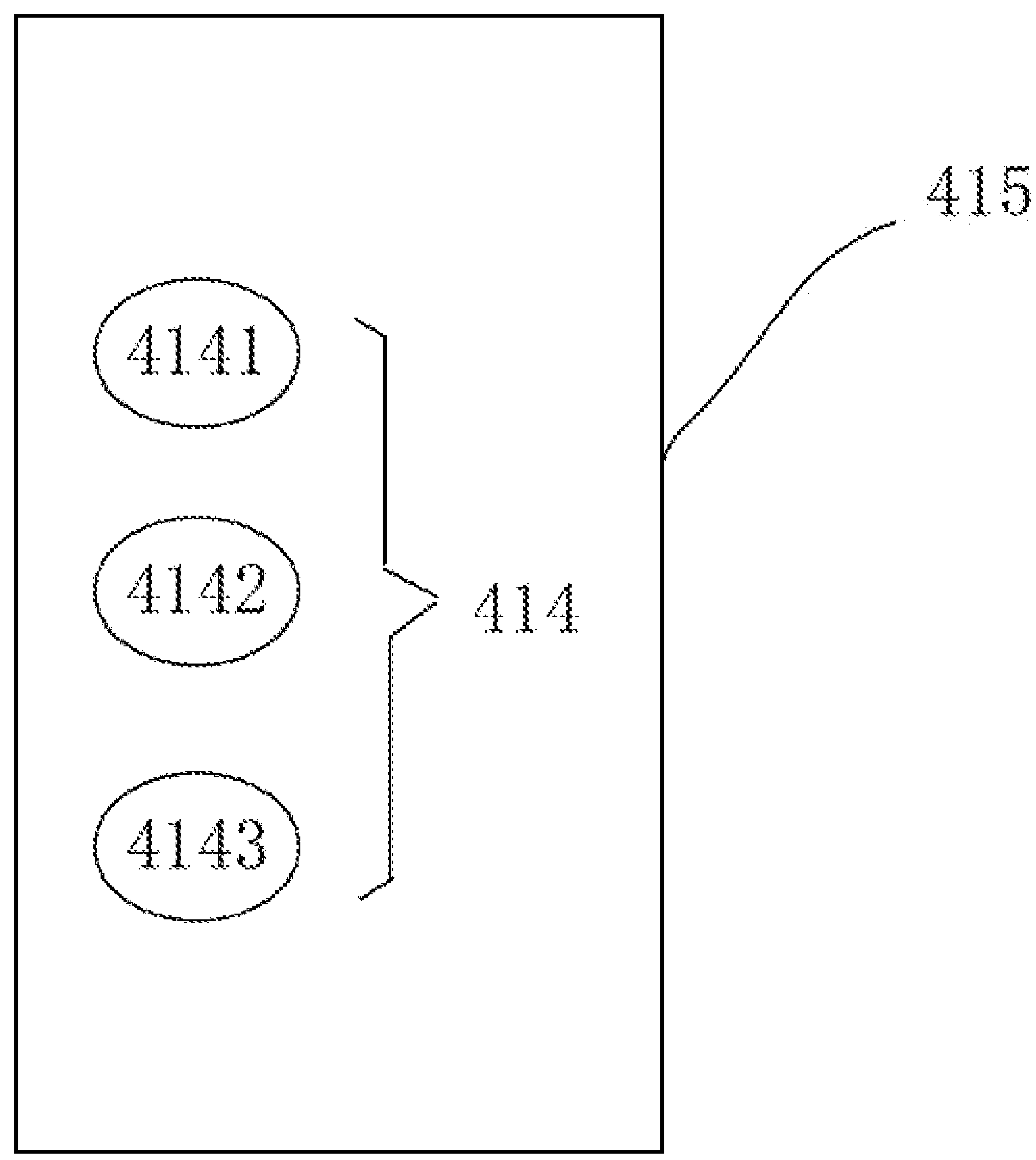


FIG. 3

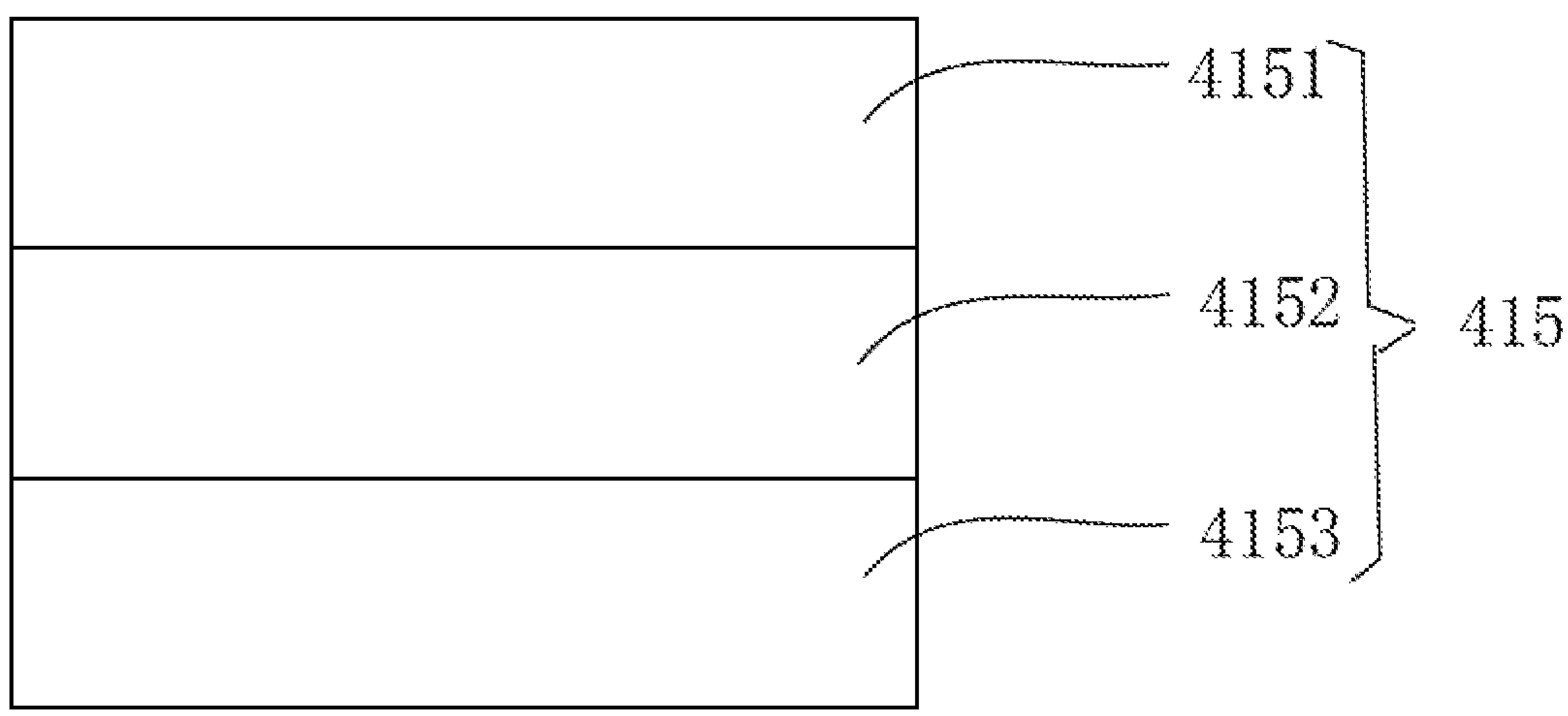


FIG. 4

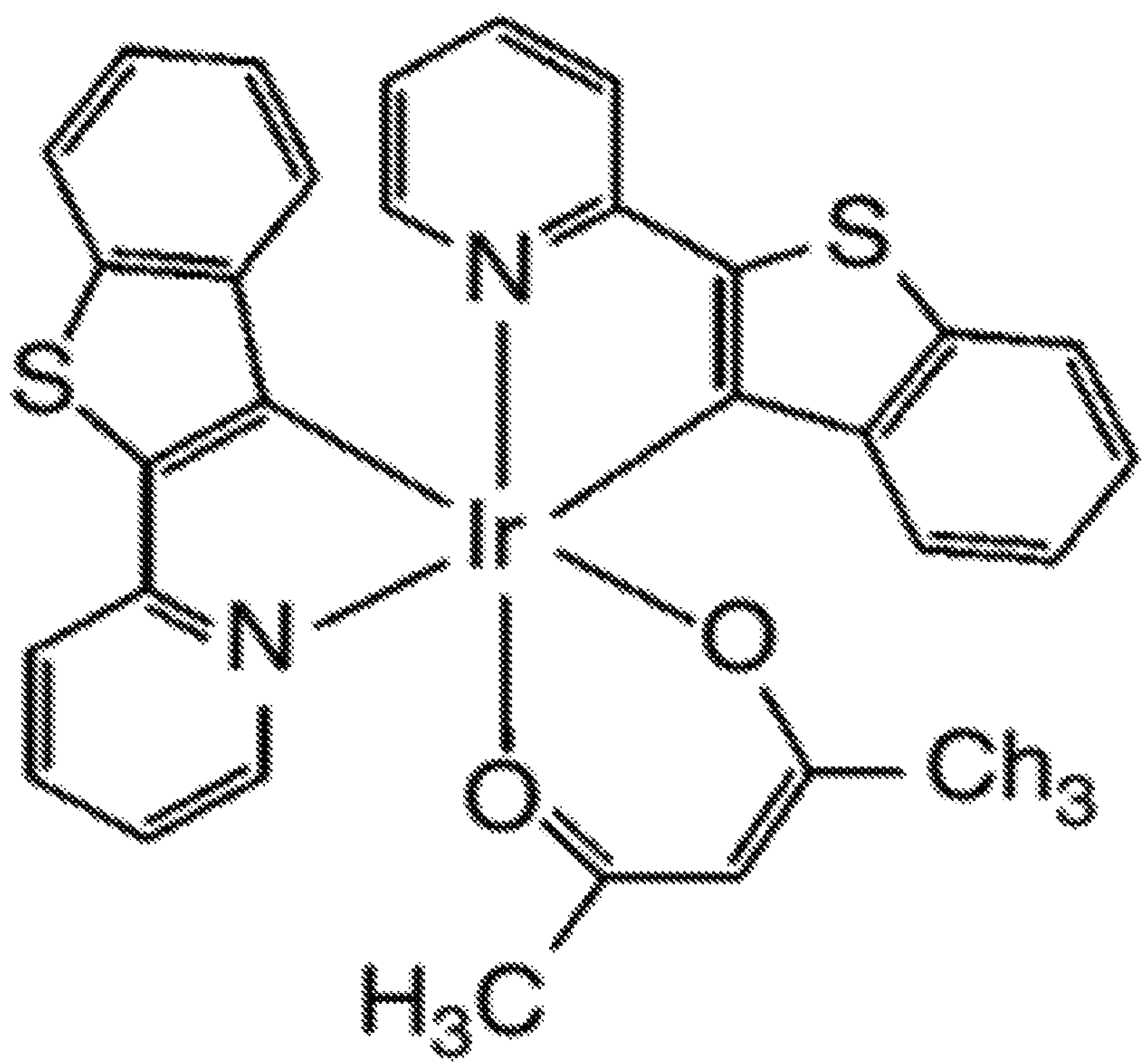


FIG. 5

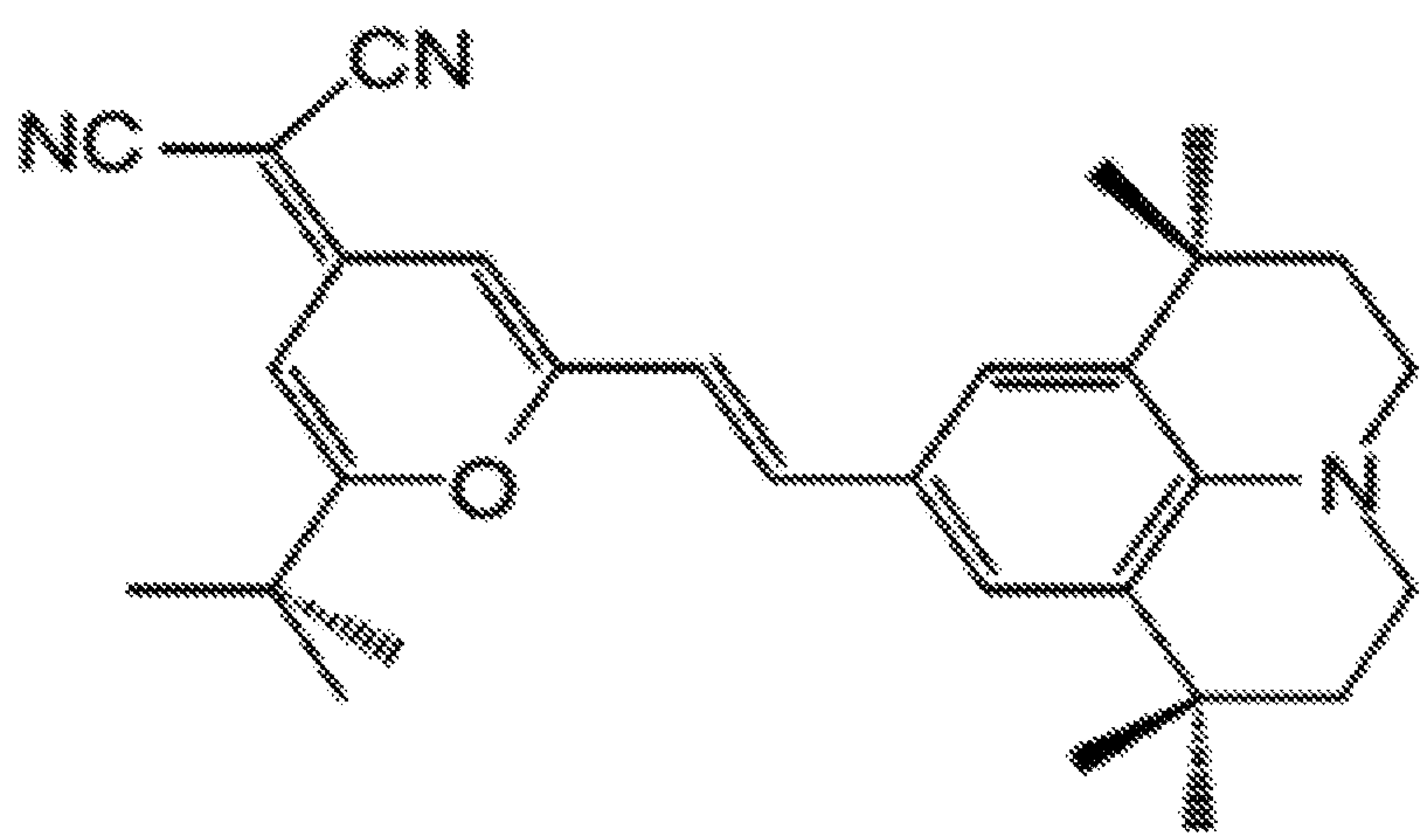


FIG. 6

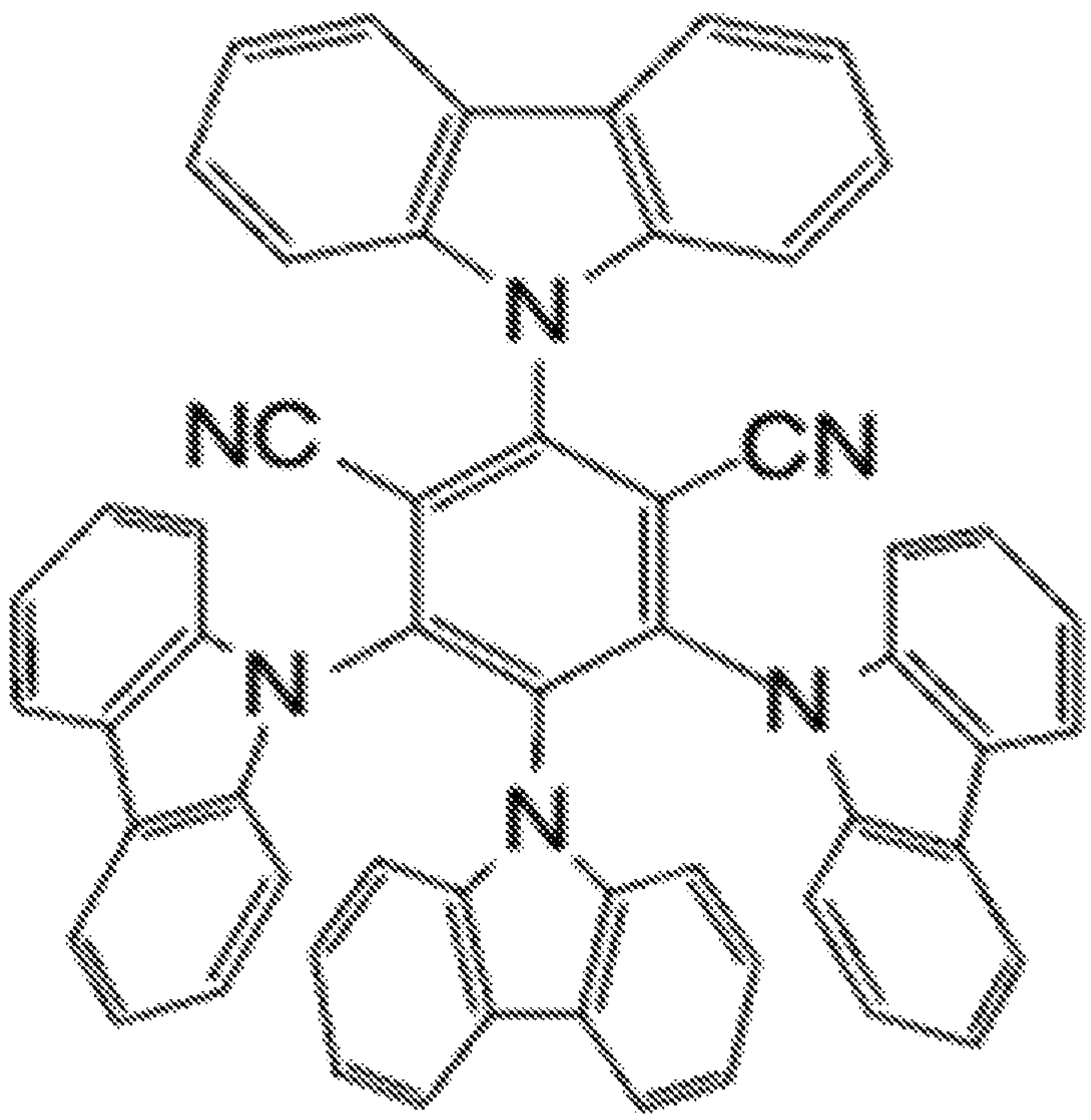


FIG. 7

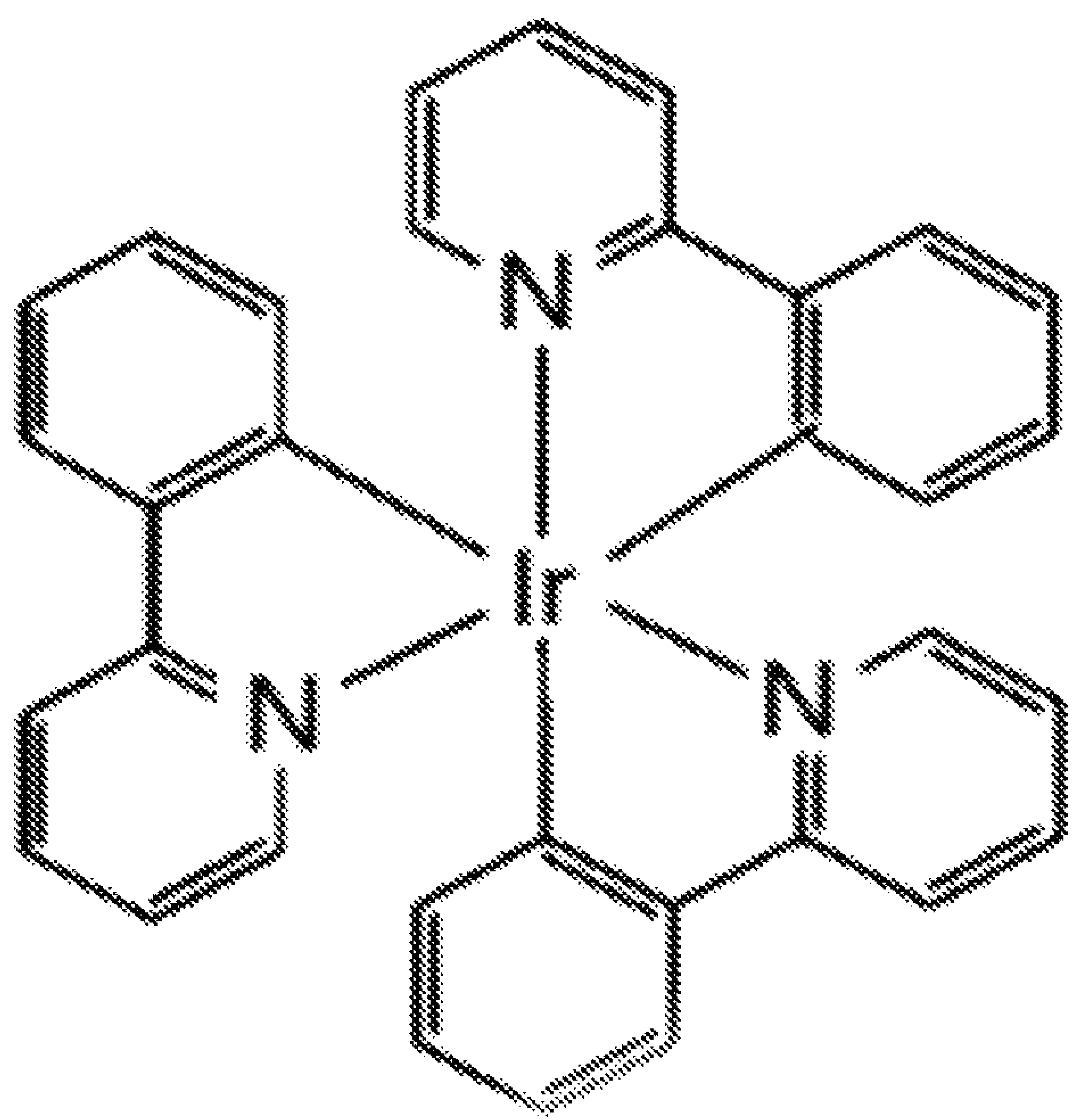


FIG. 8

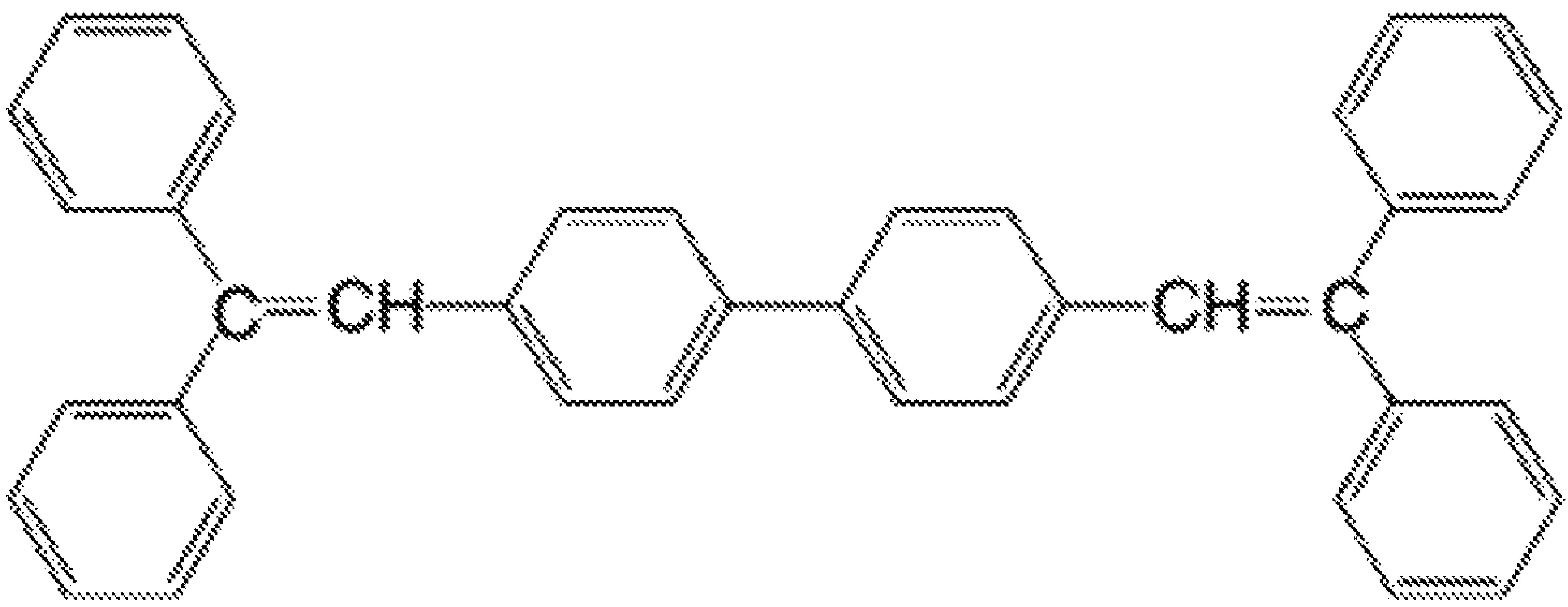


FIG. 9

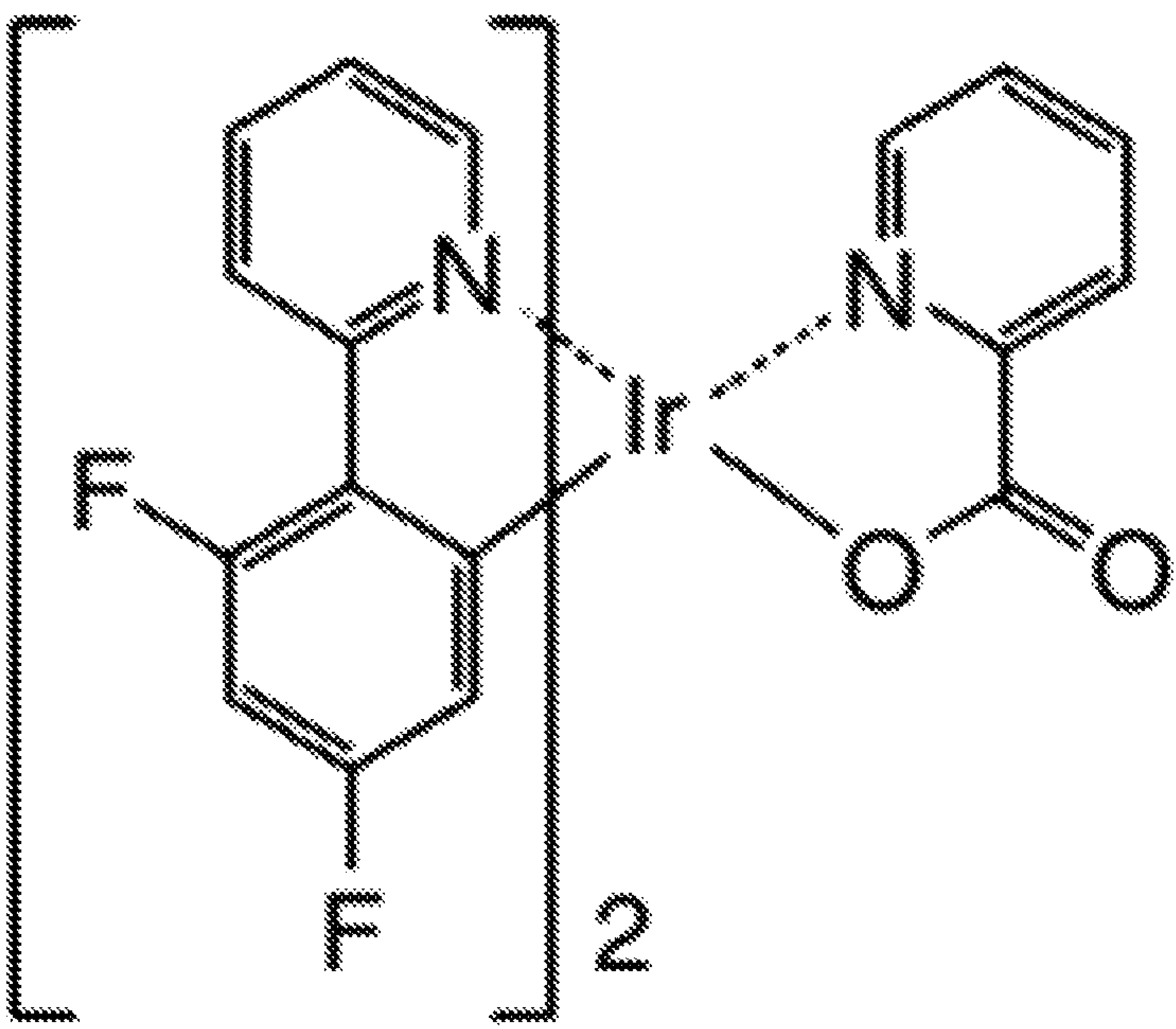


FIG. 10

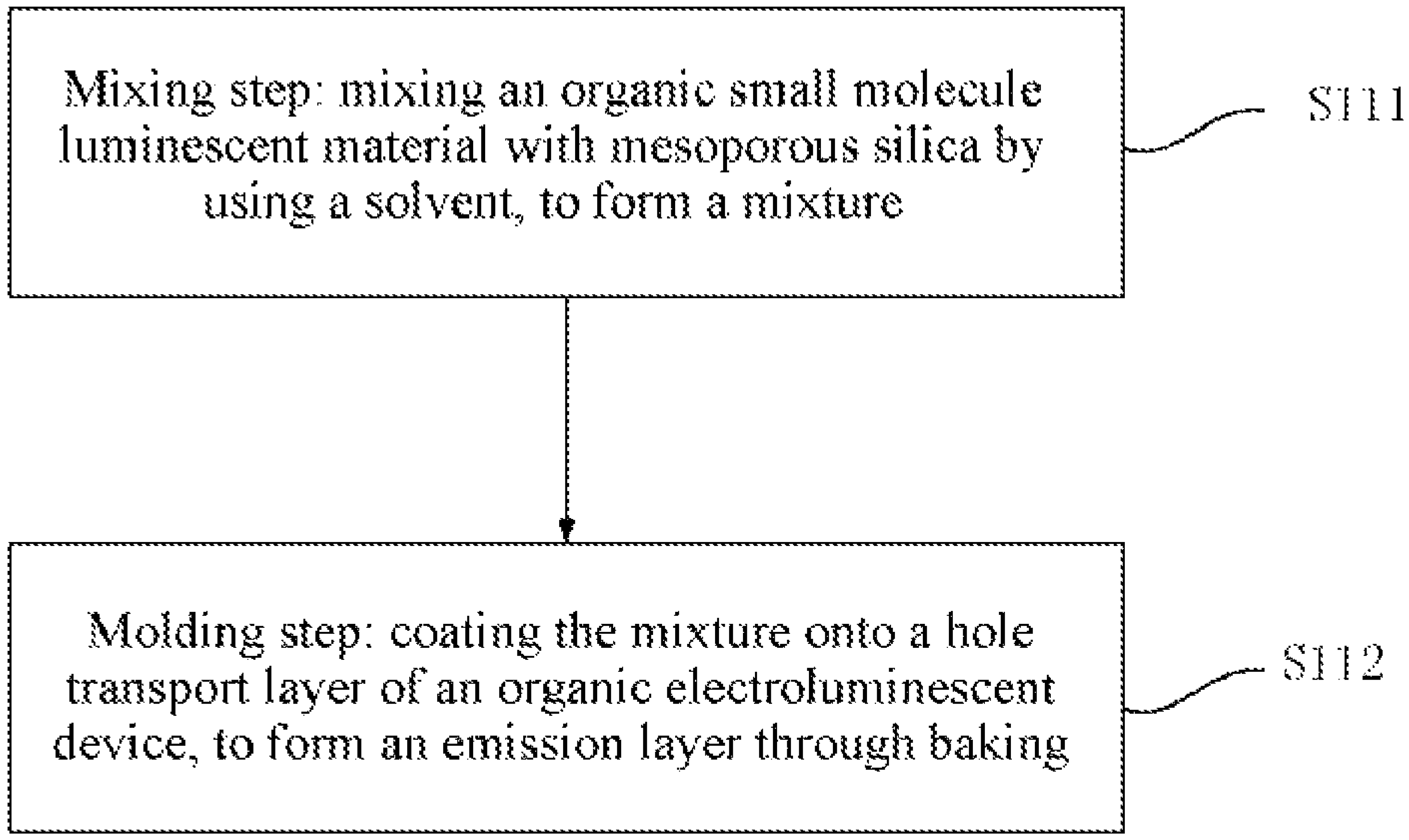

Mixing step: mixing an organic small molecule luminescent material with mesoporous silica by using a solvent, to form a mixture
S111
Molding step: coating the mixture onto a hole transport layer of an organic electroluminescent device, to form an emission layer through baking
S112

FIG. 11

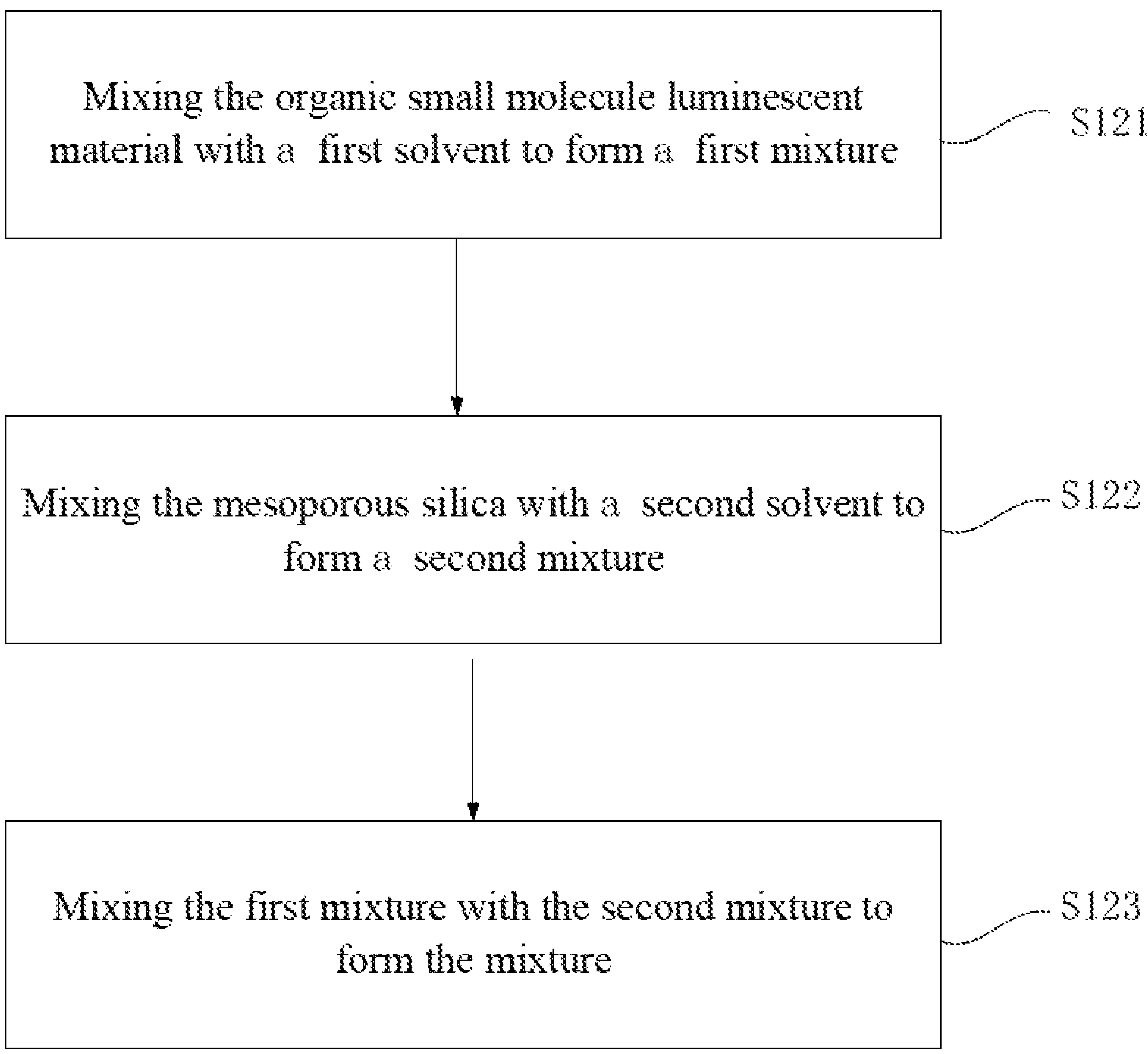

Mixing the organic small molecule luminescent material with a first solvent to form a first mixture
S121
Mixing the mesoporous silica with a second solvent to form a second mixture
S122
Mixing the first mixture with the second mixture to form the mixture
S123

FIG. 12

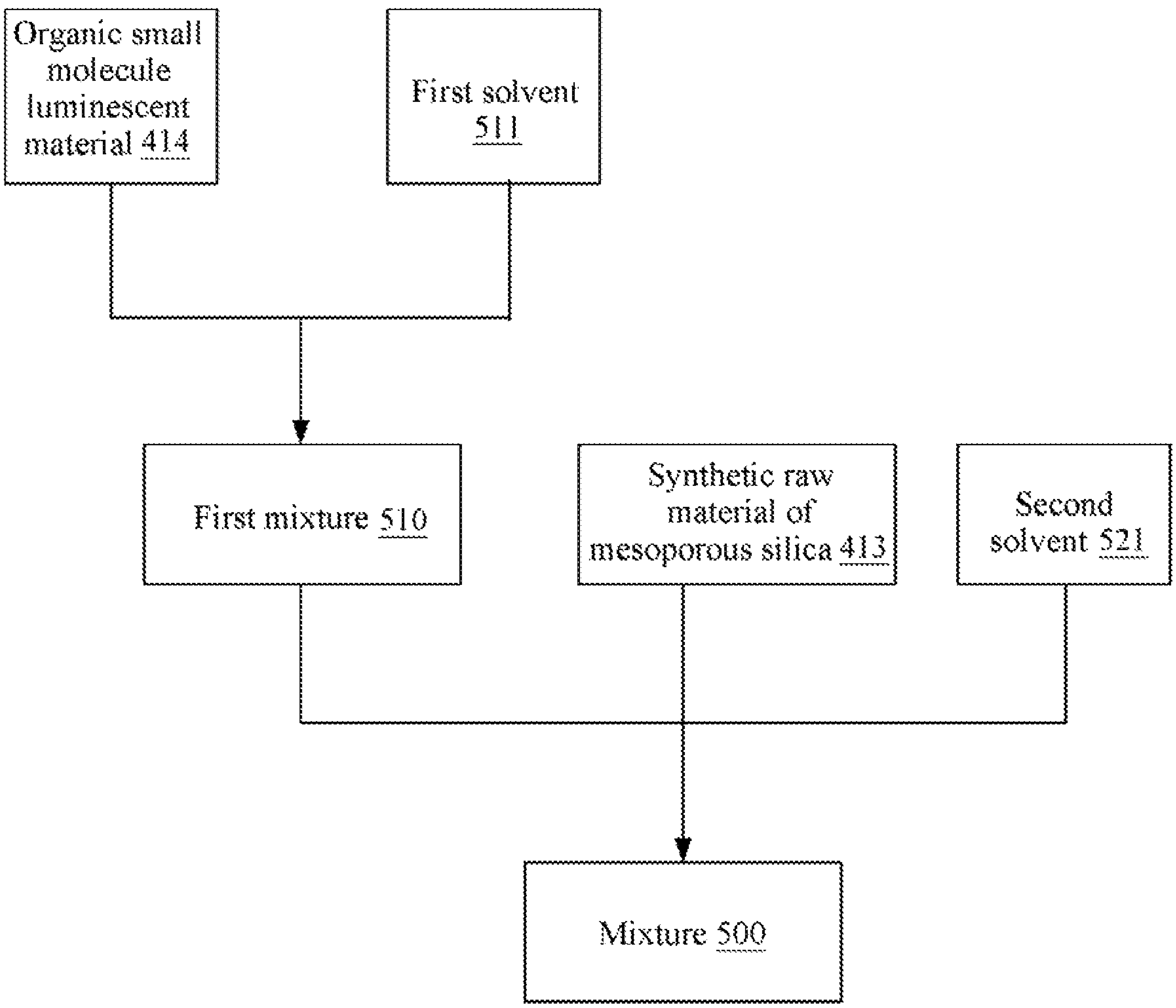

Organic small molecule luminescent material 414
First solvent 511
First mixture 510
Synthetic raw material of mesoporous silica 413
Second solvent 521
Mixture 500

FIG. 13

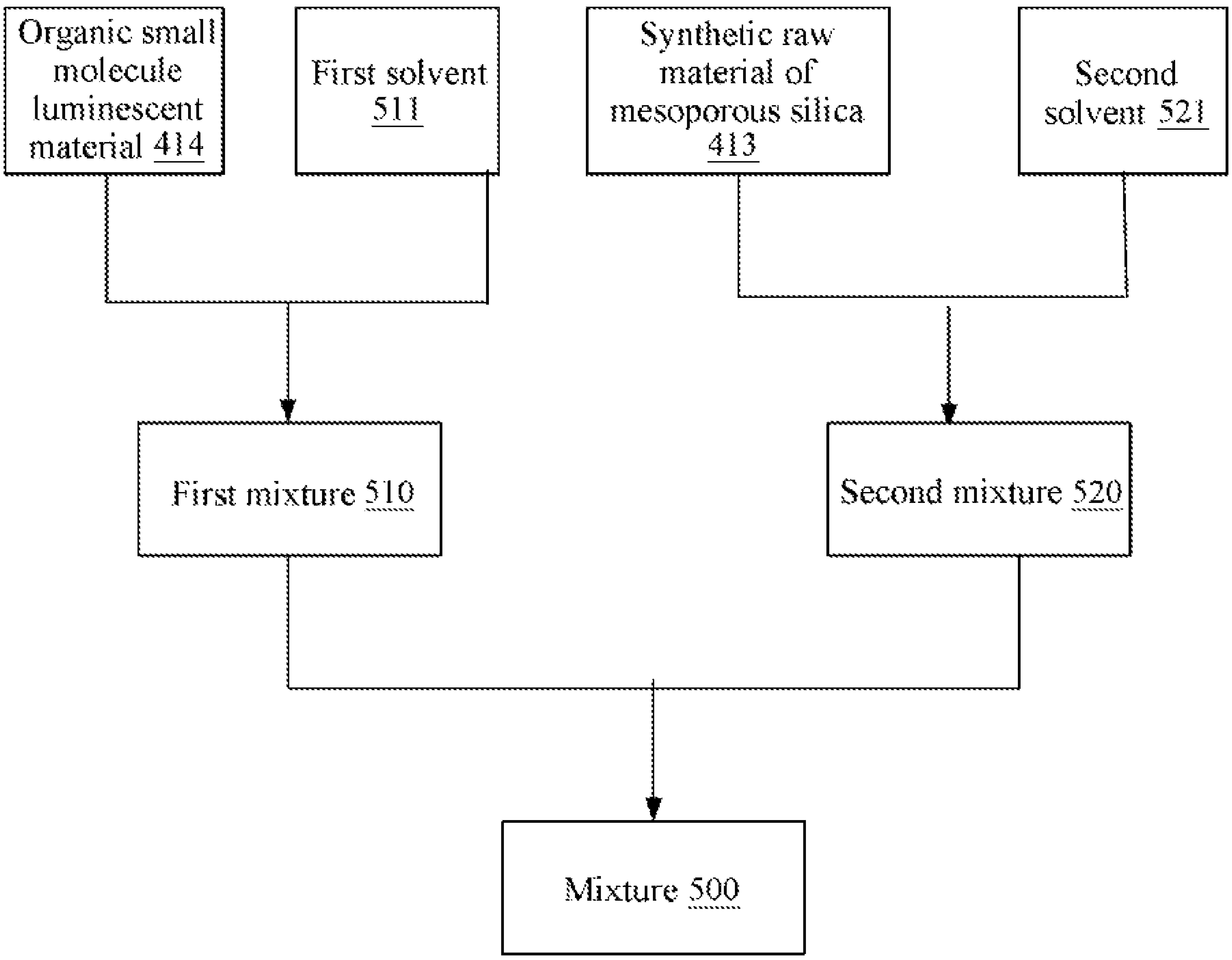

Organic small molecule luminescent material 414
First solvent 511
Synthetic raw material of mesoporous silica 413
Second solvent 521
First mixture 510
Second mixture 520
Mixture 500

FIG. 14

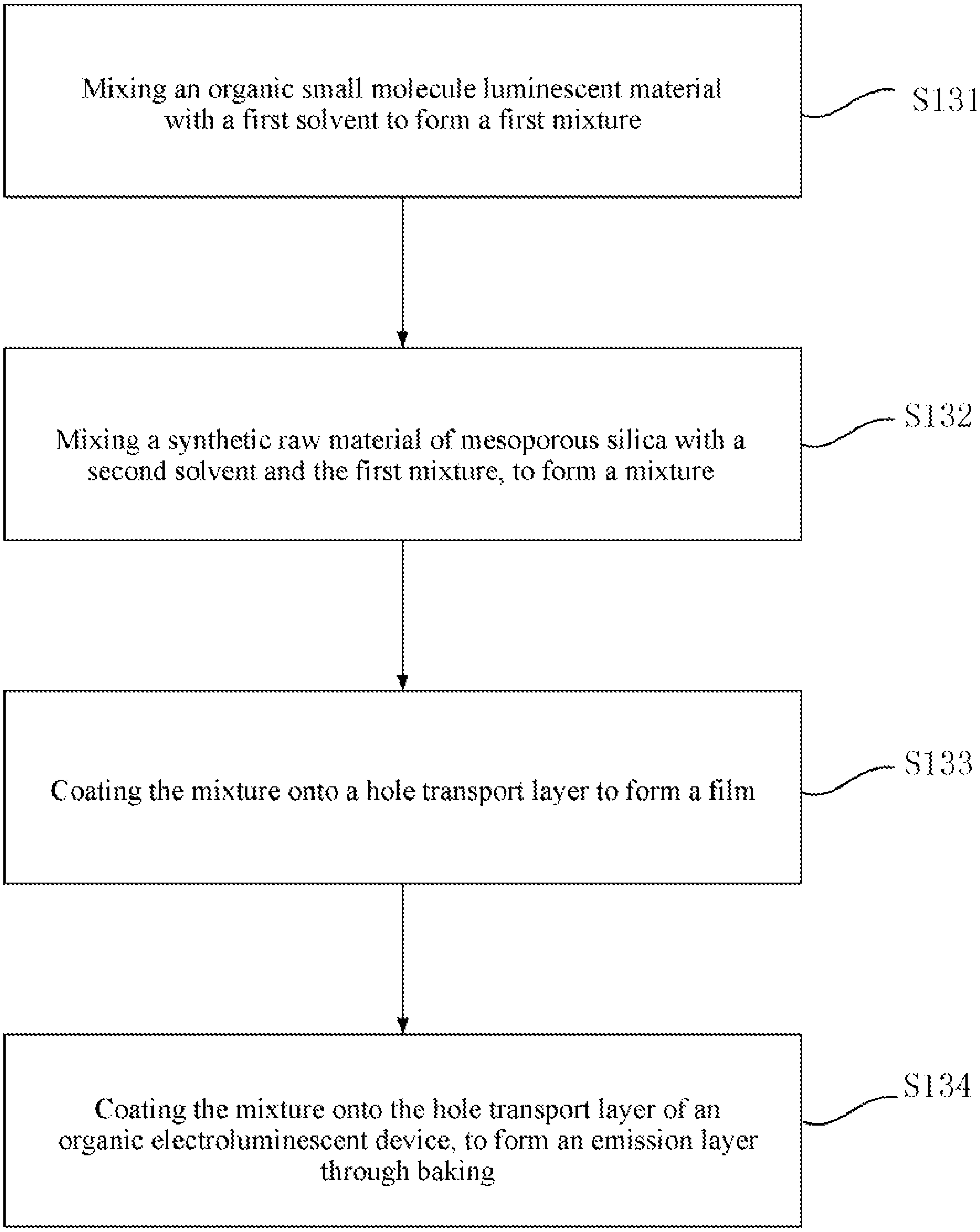

Mixing an organic small molecule luminescent material with a first solvent to form a first mixture
S131
Mixing a synthetic raw material of mesoporous silica with a second solvent and the first mixture, to form a mixture
S132
Coating the mixture onto a hole transport layer to form a film
S133
Coating the mixture onto the hole transport layer of an organic electroluminescent device, to form an emission layer through baking
S134

FIG. 15

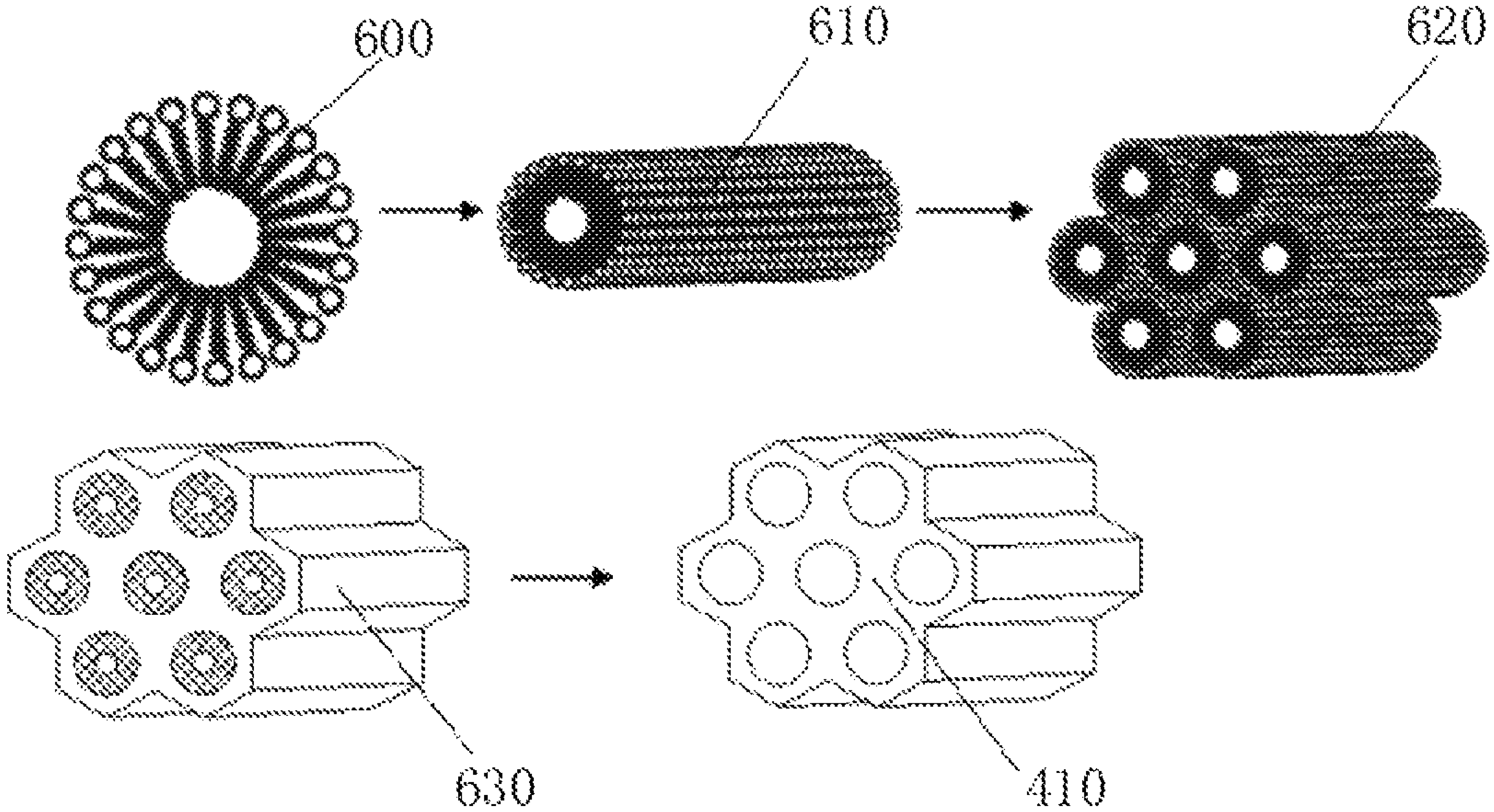


FIG. 16

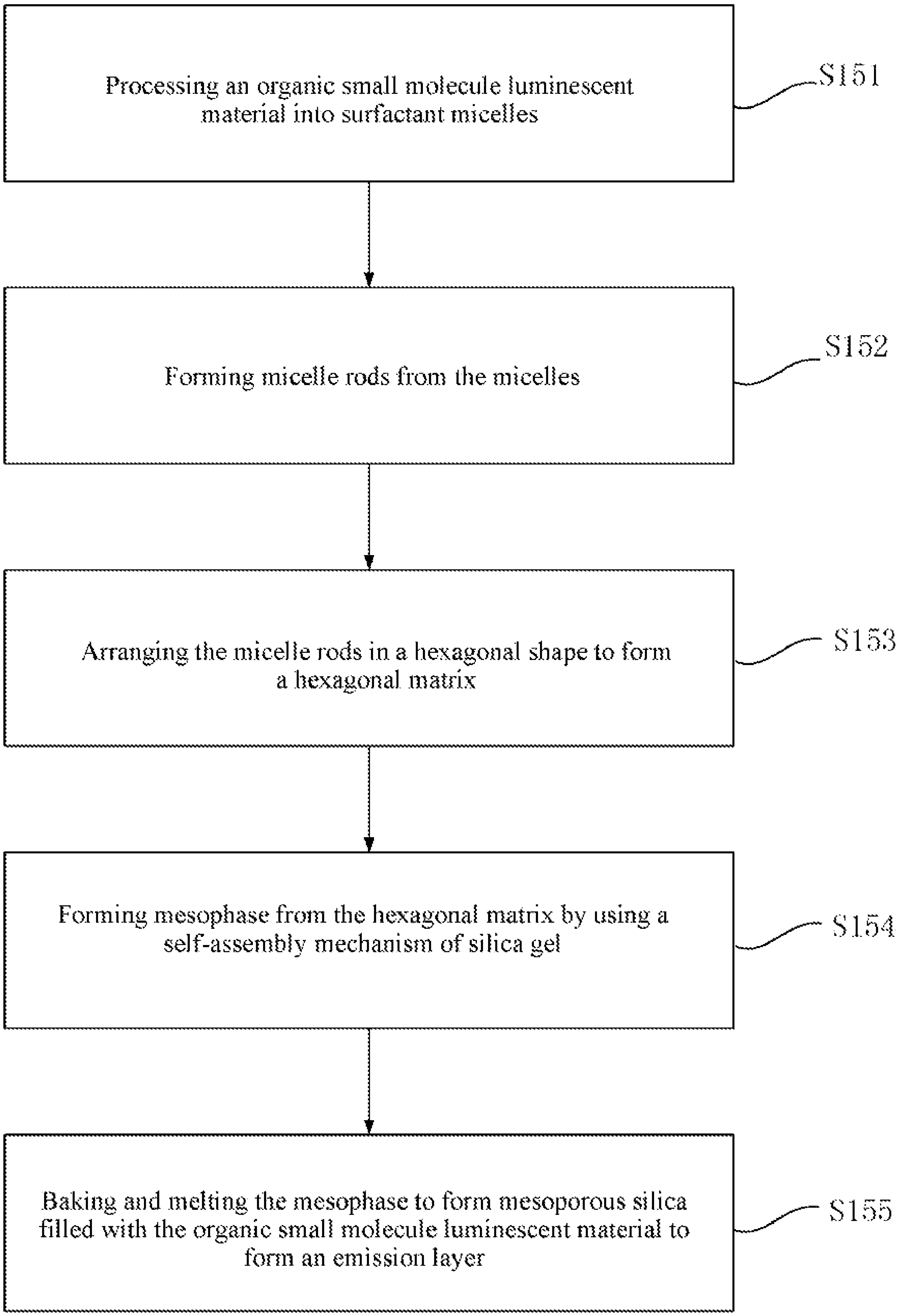

Processing an organic small molecule luminescent material into surfactant micelles
S151
Forming micelle rods from the micelles
S152
Arranging the micelle rods in a hexagonal shape to form a hexagonal matrix
S153
Forming mesophase from the hexagonal matrix by using a self-assembly mechanism of silica gel
S154
Baking and melting the mesophase to form mesoporous silica filled with the organic small molecule luminescent material to form an emission layer
S155

FIG. 17

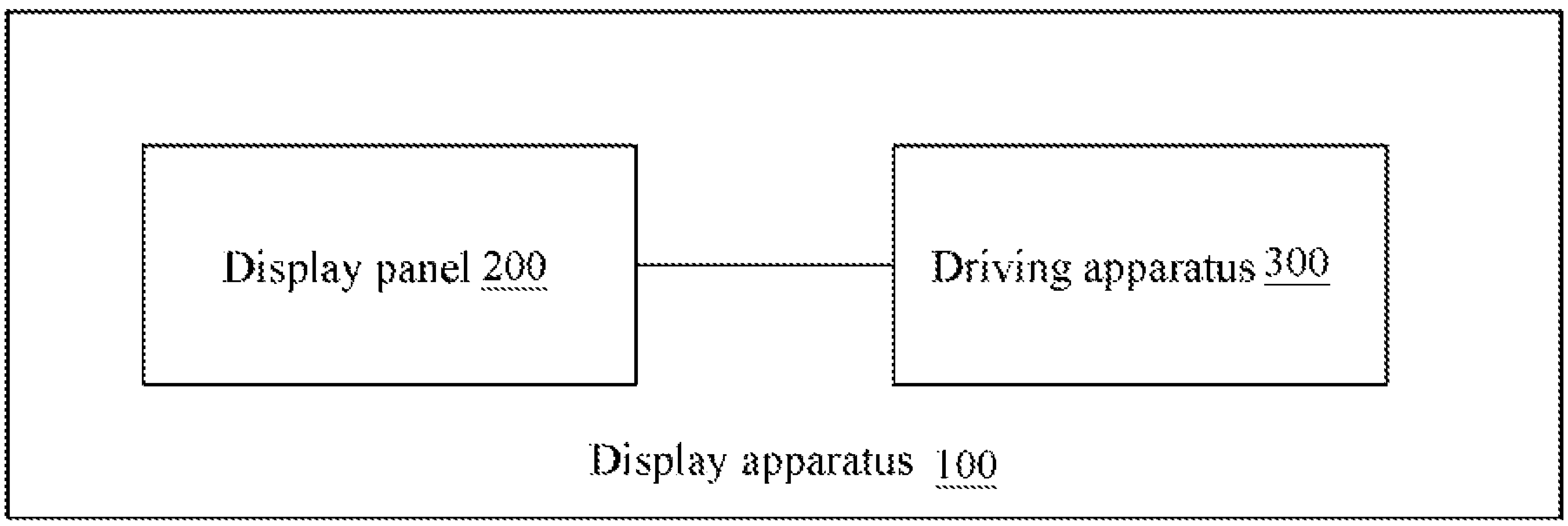

Display panel 200
Driving apparatus 300
Display apparatus 100

FIG. 18

DISPLAY PANEL INCLUDING AN ORGANIC ELECTROLUMINESCENT DEVICE WHERE AN ORGANIC SMALL MOLECULE LUMINESCENT MATERIAL IS DISPOSED IN A MAIN BODY MADE OF MESOPOROUS SILICA, METHOD FOR MANUFACTURING THE SAME, AND DISPLAY DEVICE

CROSS REFERENCE OF RELATED APPLICATIONS

This application claims the priority to the Chinese Patent Application No. CN201811473419.3, filed with National Intellectual Property Administration, PRC on Dec. 4, 2018 and entitled "DISPLAY PANEL, METHOD FOR MANUFACTURING DISPLAY PANEL, AND DISPLAY DEVICE", which is incorporated herein by reference in its entirety.

TECHNICAL FIELD

This application relates to the field of display technologies, and in particular, to a display panel, a method for manufacturing a display panel, and a display device.

BACKGROUND

The description herein provides only background information related to this application, but does not necessarily constitute the conventional art.

Organic Light Emitting Diode or Organic Light Emitting Diode Display (OLED), or referred to as organic electroluminescent diode, is a novel display technology developed since the mid-20th century. Compared with a liquid crystal display, the organic electroluminescent diode has the advantages of all solid state, active light emission, high brightness, high contrast, thin thickness, low costs, low power consumption, fast response, wide viewing angle, wide operating temperature range, and soft screen display. According to molecular sizes, organic light-emitting materials may include small molecule materials and high polymer materials.

Generally, organic light emitting molecules suffer from a severe aggregation-caused quenching effect.

SUMMARY

To achieve the foregoing objective, this application provides a display panel, a method for manufacturing a display panel, and a display device, to reduce aggregation of organic light emitting molecules.

This application discloses a display panel. The display panel includes an organic electroluminescent device. The organic electroluminescent device includes an emission layer. The emission layer includes a main body made of mesoporous silica and a dopant made of an organic small molecule luminescent material. The dopant is arranged in the main body.

Optionally, the organic electroluminescent device includes: a substrate; an anode layer, arranged on a surface of the substrate; a hole injection layer, arranged on a surface of the anode layer; a hole transport layer, arranged on a surface of the hole injection layer; an emission layer, arranged on a surface of the hole transport layer; an electron output layer, arranged on a surface of the emission layer; an electron injection layer, arranged on a surface of the electron output layer; and a cathode layer, arranged on a surface of the electron injection layer and electrically connected to the anode layer.

Optionally, a molecular weight of the organic small molecule luminescent material is less than or equal to 2000.

Optionally, the main body includes a plurality of cylindrical holes, the holes run through the main body, and the holes are filled with the organic small molecule luminescent material.

Optionally, an outer wall of the main body is regular hexagonal.

Optionally, the organic small molecule luminescent material includes an organic small molecule red-light emitting material, an organic small molecule green-light emitting material, and an organic small molecule blue-light emitting material, the emission layer includes a plurality of illuminants, and each of the illuminants is made of a mixture of the organic small molecule red-light emitting material, the organic small molecule green-light emitting material, and the organic small molecule blue-light emitting material.

Optionally, the organic small molecule red-light emitting material, the organic small molecule green-light emitting material, and the organic small molecule blue-light emitting material are mixed in a same layer of the illuminant.

Optionally, the organic small molecule luminescent material includes an organic small molecule red-light emitting material, an organic small molecule green-light emitting material, and an organic small molecule blue-light emitting material, the emission layer includes a plurality of illuminants, each of the illuminants includes a red emission layer, a green emission layer, and a blue emission layer, the red emission layer is made of the organic small molecule red-light emitting material, the green emission layer is made of the organic small molecule green-light emitting material, and the blue emission layer is made of the organic small molecule blue-light emitting material.

Optionally, positions of the red emission layer, the green emission layer, and the blue emission layer in a same illuminant are exchangeable.

Optionally, the display panel is an organic light emitting display panel.

Optionally, no reaction occurs between the main body and the dopant.

This application further discloses a method for manufacturing a display panel. The display panel includes an organic electroluminescent device. The organic electroluminescent device includes an emission layer. The manufacturing method includes a step of molding the emission layer: arranging an organic small molecule luminescent material in a main body material made of mesoporous silica, to form the emission layer.

Optionally, the step of molding the emission layer includes:

a mixing step: mixing the organic small molecule luminescent material with the mesoporous silica by using a solvent, to form a mixture; and

a molding step: coating the mixture onto a hole transport layer of the organic electroluminescent device, to form the emission layer through baking.

Optionally, the mixing step includes:

mixing the organic small molecule luminescent material with a first solvent to form a first mixture;

mixing the mesoporous silica with a second solvent to form a second mixture; and

mixing the first mixture with the second mixture to form the mixture.

Optionally, no chemical reaction occurs between the first solvent and the second solvent.

Optionally, the mixture of the organic small molecule luminescent material and the mesoporous silica is baked at a temperature of 250 to 350 degrees Celsius for 0.5 to 5 hours.

This application further discloses a display device, including the foregoing display panel and a driving apparatus configured to drive the display panel.

Compared with a solution in which the emission layer includes another type of organic light-emitting material, in this application, the organic small molecule luminescent material is arranged in the main body made of the mesoporous silica, to effectively disperse the organic small molecule luminescent material, and reduce the probability of aggregating into clusters. In addition, the combination of organic small molecules and inorganic silica prolongs the overall service life of the device.

BRIEF DESCRIPTION OF DRAWINGS

The drawings included are used for providing understanding of embodiments of this application, constitute part of the specification, and are used for illustrating implementations of this application, and interpreting principles of this application together with text description. Apparently, the accompanying drawings in the following description show merely some embodiments of this application, and a person of ordinary skill in the art may still derive other drawings from these accompanying drawings without creative efforts. In the figures:

FIG. **1** is a schematic diagram of an organic electroluminescent device according to an embodiment of this application.

FIG. **2** is a schematic diagram of an emission layer according to an embodiment of this application.

FIG. **3** is a schematic diagram of an illuminant according to an embodiment of this application.

FIG. **4** is a schematic diagram of another illuminant according to an embodiment of this application.

FIG. **5** is a schematic diagram of an organic small molecule red-light emitting material according to an embodiment of this application.

FIG. **6** is a schematic diagram of another organic small molecule red-light emitting material according to an embodiment of this application.

FIG. **7** is a schematic diagram of an organic small molecule green-light emitting material according to an embodiment of this application.

FIG. **8** is a schematic diagram of another organic small molecule green-light emitting material according to an embodiment of this application.

FIG. **9** is a schematic diagram of an organic small molecule blue-light emitting material according to an embodiment of this application.

FIG. **10** is a schematic diagram of another organic small molecule blue-light emitting material according to an embodiment of this application.

FIG. **11** is a flowchart of a method for manufacturing a display panel according to an embodiment of this application.

FIG. **12** is a flowchart of a mixing step in a method for manufacturing a display panel according to an embodiment of this application.

FIG. **13** is a schematic diagram of a mixing step in a method for manufacturing a display panel according to an embodiment of this application.

FIG. **14** is a schematic diagram of a mixing step in a method for manufacturing a display panel according to an embodiment of this application.

FIG. **15** is a flowchart of a method for manufacturing a display panel according to an embodiment of this application.

FIG. **16** is a schematic diagram of another method for manufacturing a display panel according to an embodiment of this application.

FIG. **17** is a flowchart of another method for manufacturing a display panel according to an embodiment of this application.

FIG. **18** is a schematic diagram of a display device according to an embodiment of this application.

DETAILED DESCRIPTION OF EMBODIMENTS

It should be understood that terms used herein, specific structures and functional details disclosed herein are merely for describing specific embodiments and are representative. However, this application may be specifically implemented in many alternative forms, and should not be construed as being limited to the embodiments set forth herein.

In the description of this application, the terms such as "first" and "second" are used only for the purpose of description, and should not be understood as indicating the relative importance or implicitly specifying the quantity of the indicated technical features. Therefore, unless otherwise stated, a feature defined by "first" or "second" can explicitly or implicitly include one or more features; and "a plurality of" means two or more. The terms "include", "comprise", and any variant thereof are intended to cover non-exclusive inclusion, and do not preclude the presence or addition of one or more other features, integers, steps, operations, elements, components, and/or combinations thereof.

In addition, terms indicating orientation or position relationships, for example, "center", "transverse", "on", "below", "left", "right", "vertical", "horizontal", "top", "bottom", "inside", and "outside" are described based on orientation or relative position relationships shown in the accompanying drawings, and are used only for ease and brevity of description of this application, rather than indicating that the mentioned apparatus or component needs to have a particular orientation or needs to be constructed and operated in a particular orientation. Therefore, such terms should not be construed as limiting of this application.

In addition, unless otherwise explicitly specified or defined, the terms such as "mount", "install", "connect", and "connection" should be understood in a broad sense. For example, the connection may be a fixed collection, a detachable connection, or an integral connection; or the connection may be a mechanical connection or an electrical connection; or the connection may be a direct connection, an indirect connection through an intermediary, or internal communication between two components. A person of ordinary skill in the art may understand the specific meanings of the foregoing terms in this application according to specific situations.

This application is specifically described below with reference to the accompanying drawings and optional embodiments.

As shown in FIG. **1** to FIG. **10**, an embodiment of this application discloses a display panel **200**. The display panel **200** includes an organic electroluminescent device **400**. The organic electroluminescent device **400** includes an emission layer **410**. The emission layer **410** includes a main body **411** made of mesoporous silica **413** and a dopant **412** made of an organic small molecule luminescent material **414**. The dopant **412** is arranged in the main body **411**. No reaction occurs between the main body **411** and the dopant **412**. In this solution, the organic small molecule luminescent material **414** is arranged in the main body **411** made of the mesoporous silica **413**, to effectively disperse the organic small molecule luminescent material **414**, and reduce the probability of aggregating into clusters. In addition, the combination of organic small molecules and inorganic silica prolongs the overall service life of the device. The display panel **200** is an Organic Light Emitting Diode (OLED) display panel.

In one or more embodiments, as shown in FIG. **1**, the organic electroluminescent device **400** includes: a substrate **480**; an anode layer **470** arranged on a surface of the substrate **480**; a hole injection layer **460** arranged on a surface of the anode layer **470**; a hole transport layer **450** arranged on a surface of the hole injection layer **460**: an emission layer **410** arranged on a surface of the hole transport layer **450**; an electron output layer **440** arranged on a surface of the emission layer **410**; an electron injection layer **430** arranged on a surface of the electron output layer **440**; and a cathode layer **420** arranged on a surface of the electron injection layer **430** and electrically connected to the anode layer **470**.

In one or more embodiments, a molecular weight of the organic small molecule luminescent material **414** is less than or equal to 2000. In this solution, because the organic light-emitting material needs to be arranged in the main body **411** made of the mesoporous silica **413**, and apertures of mesopores range from 2 to 50 nm, it is difficult to fill the organic light-emitting material into the mesoporous material if the organic light-emitting material has an excessively large molecular weight. The molecular weight of 2000 exactly meets the filling requirements.

In one or more embodiments, as shown in FIG. **2**, the main body **411** includes a plurality of cylindrical holes **4111**. The holes **4111** run through the main body **411**. The holes **4111** are filled with the organic small molecule luminescent material **414**. In this solution, the use of the structures of the holes **4111** facilitates the implementation using a self-assembly molecular template solution. The holes **4111** may be cylindrical, or may be polygonal. According to different manufacturing processes and product requirements, the structures of the holes **4111** may be manufactured into different shapes. Therefore, the structures of the holes **4111** of various shapes all fall within the scope of the concept of the implementation.

An outer wall of the main body **411** is regular hexagonal.

In one or more embodiments, as shown in FIG. **3**, the organic small molecule luminescent material **414** includes an organic small molecule red-light emitting material **4141**, an organic small molecule green-light emitting material **4142**, and an organic small molecule blue-light emitting material **4143**. The emission layer **410** includes a plurality of illuminants **415**. Each of the illuminants **415** is made of a mixture of the organic small molecule red-light emitting material **4141**, the organic small molecule green-light emitting material **4142**, and the organic small molecule blue-light emitting material **4143**. In this solution, the organic small molecule red-light emitting material **4141**, the organic small molecule green-light emitting material **4142**, and the organic small molecule blue-light emitting material **4143** are mixed to form each illuminant **415**, so that each illuminant **415** can emit light in three colors, namely, red, green, and blue. The mixing form simplifies the processing process, and organic small molecule materials in three colors do not need to be separately layered, thereby reducing the processing time of the emission layer **410**.

In one or more embodiments, the organic small molecule red-light emitting material **4141**, the organic small molecule green-light emitting material **4142**, and the organic small molecule blue-light emitting material **4143** are mixed in a same layer of the illuminant **415**.

In one or more embodiments, as shown in FIG. **4**, the organic small molecule luminescent material **414** includes an organic small molecule red-light emitting material **4141**, an organic small molecule green-light emitting material **4142**, and an organic small molecule blue-light emitting material **4143**. The emission layer **410** includes a plurality of illuminants **415**. Each of the illuminants **415** includes a red emission layer **4151**, a green emission layer **4152**, and a blue emission layer **4153**. The red emission layer **4151** is made of the organic small molecule red-light emitting material **4141**. The green emission layer **4152** is made of the organic small molecule green-light emitting material **4142**. The blue emission layer **4153** is made of the organic small molecule blue-light emitting material **4143**. In this solution, each illuminant **415** is divided into three layers, namely, the red emission layer **4151**, the green emission layer **4152**, and the blue emission layer **4153**. Such a division of the illuminant **415** into smaller units facilitates adjustment and control of each illuminant **415**, so that the emission layers **410** in three different colors in each illuminant **415** are evenly distributed, improving the display effect. In addition, if a problem occurs in the illuminant **415**, corresponding modifications may be made.

In one or more embodiments, positions of the red emission layer **4151**, the green emission layer **4152**, and the blue emission layer **4153** in a same illuminant **415** are exchangeable.

In one or more embodiments, the organic small molecule red-light emitting material **4141** includes two red phosphorescent materials, namely: 2-{2-tert-butyl-6-[2-(1,1,7,7-tetramethyl-2,3,6,7-tetrahydro-1H,5H-pyrido[3,2,1-ij]quinolin-9-yl)-vinyl]-pyran-4-ylidene}-malononitrile whose English name is (btp)2lr(acac); and 4-(dicyanomethylene)-2-tert-butyl-6-(1,1,7,7-tetramethyl-julolidyl-4-vinyl)-4H-pyran whose English name is DCJTB. Chemical structures of the two materials are respectively shown in FIG. **5** and FIG. **6**. In this solution, the two materials provided can meet the requirements of this application on color and molecular size.

In one or more embodiments, the organic small molecule green-light emitting material **4142** includes two green phosphorescent materials, namely: 2,4,5,6-tetra(9-carbazolyl) iso-phthalonitrile whose English name is 4CzlPN; and tris (2-phenyl pyridinato)iridium whose English name is lr(ppy) 3. Chemical structures of the two materials are respectively shown in FIG. **7** and FIG. **8**. In this solution, the two materials provided can meet the requirements of this application on color and molecular size.

In one or more embodiments, the organic small molecule blue-light emitting material **4143** includes two blue phosphorescent materials, namely: 4,4'-bis(2,2-diphenylvinyl)-1,1'-biphenyl whose English name is DPVBl: and bis[(4,6-difluorophenyl)-pyridinato-N,C2'] (picolinate) iridium whose English name is Flrpic. Chemical structures of the two materials are respectively shown in FIG. **9** and FIG. **10**. In this solution, the two materials provided can meet the requirements of this application on color and molecular size.

As shown in FIG. **11** and FIG. **12**, in one or more embodiments of this application, a method for manufacturing a display panel **200** is disclosed. The display panel **200** includes an organic electroluminescent device **400**. The organic electroluminescent device **400** includes an emission layer **410**. The manufacturing method includes a step of molding the emission layer **410**: arranging an organic small molecule luminescent material in a main body material made of mesoporous silica, to form the emission layer.

In one or more embodiments, as shown in FIG. **11**, the step of molding the emission layer **410** includes:

S111: a mixing step: mixing the organic small molecule luminescent material with the mesoporous silica by using a solvent, to form a mixture; and

S112: a molding step: coating the mixture onto a hole transport layer of the organic electroluminescent device, to form the emission layer through baking.

In this solution, a thermal evaporation method is generally used for existing industrial organic small molecules. A thermal evaporation device requires high costs, and has great limitations in manufacturing a large-area panel. Therefore, the use of the solution method can reduce the costs, is suitable for manufacturing of a large-size panel, and can simplify the manufacturing process. In addition, moisture in the foregoing mixture **500** is evaporated through baking, to obtain a final emission layer **410**. The baking does not affect the state of the combination of the mesoporous silica **413** and the organic small molecule luminescent material **414**, and does not cause the mixture **500** to react.

In one or more embodiments, as shown in FIG. **12**, the mixing step includes:

S121: mixing the organic small molecule luminescent material with a first solvent to form a first mixture;

S122: mixing the mesoporous silica with a second solvent to form a second mixture; and

S123: mixing the first mixture with the second mixture to form the mixture.

As shown in FIG. **13** and FIG. **14**, the order of the first two steps is not fixed; and no chemical reaction occurs between the first solvent **511** and the second solvent **521**. In this solution, the organic small molecule luminescent material **414** is first mixed with the first solvent **511**, so that the organic small molecule luminescent material **414** is evenly distributed in the first solvent **511**. The mesoporous silica **413** and the second solvent **521** are added into the organic small molecule luminescent solution that is evenly mixed, so that the mesoporous silica **413** is in even contact with the organic small molecule luminescent material **414**, to avoid the case in which some mesoporous silica **413** is in contact with a relatively large quantity of the organic small molecule luminescent material **414** but some mesoporous silica **413** is in contact with only a relatively small quantity of the luminescent material. In addition, adding the second solvent **521** can dilute the organic small molecule luminescent material **414** and the mesoporous silica **413**, maintaining the even distribution of the two.

In one or more embodiments, the mixture **500** of the organic small molecule luminescent material **414** and the mesoporous silica **413** is baked at a temperature of 250 to 350 degrees Celsius for 0.5 to 5 hours. In this solution, the baking temperature is set to 250 to 350 degrees Celsius and the time is set to 0.5 to 5 hours because such a condition is relatively mild and does not destroy the structure of the organic small molecule luminescent material **414** and the mesoporous silica **413**.

As shown in FIG. **15**, in one or more embodiments of this application, a method for manufacturing a display panel **200** is further disclosed. The manufacturing method includes:

S131: mixing an organic small molecule luminescent material with a first solvent to form a first mixture;

S132: mixing a synthetic raw material of mesoporous silica with a second solvent and the first mixture, to form a mixture;

S133: coating the mixture onto a hole transport layer to form a film; and

S134: coating the mixture onto the hole transport layer of an organic electroluminescent device, to form an emission layer through baking.

As shown in FIG. **16** and FIG. **17**, in one or more embodiments of this application, a method for manufacturing a display panel **200** is further disclosed. The manufacturing method includes:

S151: processing an organic small molecule luminescent material into surfactant micelles;

S152: forming micelle rods from the micelles;

S153: arranging the micelle rods in a hexagonal shape to form a hexagonal matrix:

S154: forming mesophase from the hexagonal matrix by using a self-assembly mechanism of silica gel; and

S155: baking and melting the mesophase to form mesoporous silica filled with the organic small molecule luminescent material to form an emission layer.

As shown in FIG. **18**, in one or more embodiments of this application, a display device **100** is further disclosed. The display device **100** includes the foregoing display panel **200** and a driving apparatus **300** configured to drive the display panel **200**.

It should be noted that the sequence numbers of steps involved in a specific solution should not be considered as limiting the order of steps as long as the implementation of this solution is not affected. The steps appearing earlier may be executed earlier than, later than, or at the same time as those appearing later. Such implementations shall all be considered as falling within the protection scope of this application as long as this solution can be implemented.

The foregoing contents are detailed descriptions of this application in conjunction with specific optional embodiments, and it should not be considered that the specific implementation of this application is limited to these descriptions. A person of ordinary skill in the art can further make simple deductions or replacements without departing from the concept of this application, and such deductions or replacements should all be considered as falling within the protection scope of this application.

What is claimed is:

1. A display panel, comprising an organic electroluminescent device, wherein the organic electroluminescent device comprises an emission layer, and the emission layer comprises:

a main body, made of mesoporous silica; and

a dopant, made of an organic small molecule luminescent material, and arranged in the main body;

wherein a molecular weight of the organic small molecule luminescent material is less than or equal to 2000.

2. The display panel according to claim **1**, wherein the main body comprises a plurality of cylindrical holes, the holes run through the main body, and the holes are filled with the organic small molecule luminescent material.

3. The display panel according to claim **2**, wherein an outer wall of the main body is regular hexagonal.

4. The display panel according to claim **1**, wherein the organic small molecule luminescent material comprises an organic small molecule red-light emitting material, an organic small molecule green-light emitting material, and an organic small molecule blue-light emitting material, the emission layer comprises a plurality of illuminants, and each of the illuminants is made of a mixture of the organic small molecule red-light emitting material, the organic small molecule green-light emitting material, and the organic small molecule blue-light emitting material.

5. The display panel according to claim **4**, wherein the organic small molecule red-light emitting material, the organic small molecule green-light emitting material, and the organic small molecule blue-light emitting material are mixed in a same layer of the illuminant.

6. The display panel according to claim **1**, wherein the organic small molecule luminescent material comprises an organic small molecule red-light emitting material, an organic small molecule green-light emitting material, and an organic small molecule blue-light emitting material, the emission layer comprises a plurality of illuminants, each of the illuminants comprises a red emission layer, a green emission layer, and a blue emission layer, the red emission layer is made of the organic small molecule red-light emitting material, the green emission layer is made of the organic small molecule green-light emitting material, and the blue emission layer is made of the organic small molecule blue-light emitting material.

7. The display panel according to claim **6**, wherein positions of the red emission layer, the green emission layer, and the blue emission layer in a same illuminant are exchangeable.

8. The display panel according to claim **1**, wherein the organic electroluminescent device comprises:
- a substrate;
- an anode layer, arranged on a surface of the substrate;
- a hole injection layer, arranged on a surface of the anode layer;
- a hole transport layer, arranged on a surface of the hole injection layer;
- an emission layer, arranged on a surface of the hole transport layer;
- an electron output layer, arranged on a surface of the emission layer;
- an electron injection layer, arranged on a surface of the electron output layer; and
- a cathode layer, arranged on a surface of the electron injection layer, and electrically connected to the anode layer.

9. The display panel according to claim **1**, wherein the display panel is an organic light emitting display panel.

10. The display panel according to claim **1**, wherein no reaction occurs between the main body and the dopant.

11. A method for manufacturing a display panel, wherein the display panel comprises an organic electroluminescent device, the organic electroluminescent device comprises an emission layer, and the manufacturing method comprises a step of molding the emission layer: arranging an organic small molecule luminescent material in a main body material made of mesoporous silica, to form the emission layer;
- wherein the step of molding the emission layer comprises;
- a mixing step: mixing the organic small molecule luminescent material with the mesoporous silica by using a solvent, to form a mixture; and
- a molding step: coating the mixture onto a hole transport layer of the organic electroluminescent device to form the emission layer through baking.

12. The method for manufacturing a display panel according to claim **11**, wherein the mixing step comprises:
- mixing the organic small molecule luminescent material with a first solvent to form a first mixture;
- mixing the mesoporous silica with a second solvent to form a second mixture; and
- mixing the first mixture with the second mixture to form the mixture.

13. The method for manufacturing a display panel according to claim **12**, wherein no chemical reaction occurs between the first solvent and the second solvent.

14. The method for manufacturing a display panel according to claim **11**, wherein the mixture is baked at a temperature of 250 to 350 degrees Celsius.

15. The method for manufacturing a display panel according to claim **11**, wherein the mixture is baked for 0.5 to 5 hours.

16. A display device, comprising a display panel, wherein the display panel comprises an organic electroluminescent device, the organic electroluminescent device comprises an emission layer, and the emission layer comprises a main body made of mesoporous silica and a dopant made of an organic small molecule luminescent material and arranged in the main body;
- wherein a molecular weight of the organic small molecule luminescent material is less than or equal to 2000.

17. The display panel according to claim **16**, wherein the main body comprises a plurality of cylindrical holes, the holes run through the main body, and the holes are filled with the organic small molecule luminescent material.

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